

1141
~~11215~~

C. I. E. STUDIES
IN
EDUCATION AND PSYCHOLOGY

8/99

Publication Number 6

**Selection of Children for Secondary
Technical Education at Eleven Plus**

BY
VEDA PRAKASHA



CENTRAL INSTITUTE OF EDUCATION
DELHI
1956

Price Rupee One and Annas Eight Only. Rs. 1-35 N1

1141 ~~1281~~
4/9

FOREWORD



Whenever there is a discussion regarding the organisation of secondary education, the question of selecting children for different forms of it, naturally enough, obtrudes itself upon our attention. If secondary education has to be provided in a variety of forms, it would require some method of selecting children for these. One of the different forms of secondary education often discussed in this context is secondary technical education. The question that we have to answer in this connection is whether it is possible to select children for this type of education at eleven plus, that is, when they have completed the primary stage. This piece of research by Shri Veda Prakasha purports to give an answer to this question. He has critically evaluated the findings of the important researches carried out on this problem including a factorial study of his own. His contention, in general terms, seems to be that there is very little evidence for the practical factor at this age. Because of this as well as of certain other compelling reasons, such as the desirability of taking into account a child's interests and attitudes, he thinks, it is advisable to postpone the selection of children for secondary technical education till at least the age of thirteen or fourteen, which is the earliest age when the factor in question can be expected to emerge somewhat more definitely.

In view of its great educational significance I have no hesitation in recommending this study to all who are interested in the problem of the reorganization of secondary education. This paper was submitted by Shri Veda Prakasha to the Secondary Education Commission, and it is good to find that the Commission's recommendation that bifurcation of courses should take place at the end of the middle or Junior Secondary or Senior Basic Stage concurs with Shri Prakasha's principal thesis in this paper. The Institute wanted to publish the paper earlier, but owing to certain budgetary difficulties this could not be possible.



26.3.2008
13071

8/6/9

PREFACE

The question of reorganizing our secondary education is now before the country. The Government of India have appointed a commission to enquire into the matter and make suitable recommendations. One of the questions which is certain of coming up for discussion before the Commission will relate to the need for providing different types of secondary education at eleven plus i.e. when children have completed the primary stage. Again, one of the alternative types of secondary course of instruction which will certainly be discussed in this context is technical education. A general decision in favour of the provision of secondary technical education will assume that it is feasible to assess the practical ability (or technical aptitude) of children at this age. The present study is an attempt to examine pro and con the experimental evidence available on this issue.

It is to be regretted that the data to be discussed are all non-Indian. This could not be helped, for as far as the writer is aware, there is no Indian investigation of any great significance available on this subject. There is only one research carried out by an Indian, but the subjects of this are also non-Indian (English). Under the circumstances, the need for designing and carrying out our own experiments to discover solutions to the Indian educational problems cannot be overstressed. Pending the availability of Indian evidence, however, it should be our endeavour to study such evidence from foreign sources as has relevance to our problems. This consideration may be a justification for the present study.

Central Institute of Education, Delhi,
February, 1953.

VEDA PRAKASHA



SELECTION OF CHILDREN FOR SECONDARY TECHNICAL EDUCATION AT ELEVEN PLUS

Practical ability is often classed as one of the special abilities which ought to be taken into account in the educational and vocational guidance of adolescent school-leavers. In countries like England, however, it has now become obligatory upon the school authorities concerned to ensure that the assessment of the practical as well as other special abilities of children is completed at least by the time they are ready for transfer from the primary stage to the secondary stage i.e. at 11 plus, so that the type of secondary education for which they are finally selected is chosen in accordance with their mental proclivities. This raises the question of the measurability of special abilities such as verbal and literary ability, and practical ability, in children as young as 11 years old. There is some evidence that the verbal and literary abilities of children can be measured at this age, though many psychologists would be inclined to question it. Opinion on the issue concerning the measurability of practical ability at 11 plus is however sharply divided. On the one hand are those who think that by applying certain suitable tests of practical ability, it is possible to determine in most cases whether a given child is most likely to benefit from a secondary course of technical instruction or not; on the other are those who do not deny the possibility of diagnosing cases of extreme ability or disability at this age but maintain that in the vast majority of cases, it is not possible to assess the ability in question at 11 plus, since the function concerned does not seem to emerge till about the age of 13 or 14. In the following pages, evidence of both kinds—for and against the feasibility of assessing practical ability at 11 plus—is presented. The conflicting and inconclusive nature of the evidence bearing on the problem, if it does not establish the impossibility of measuring the special ability in question at so young an age, at least does show that the problem is not so simple as it is sometimes assumed to be. We may begin by stating the evidence in favour of the first possibility.

Of all the educationists interested in the present controversy, Alexander is the one who feels most confident that the majority of children (about 16% of boys and 8% of girls)¹ who are most likely to benefit from secondary technical education can be allocated, without many errors of judgment, to schools providing such instruction at 11 plus, on the basis of their scores on his Performance Scale of Practical Ability. His main argument appears to be that since success in the technical curriculum is determined by the two factors g and F^2 (plus certain necessary character

1. These two figures are quoted from C. Burt's "Symposium on the selection of pupils...1, General Survey", B.J.E.P. (British Journal of Educational Psychology) Vol. 17, 1947, p.63.

2. F is Alexander's symbol for the practical factor.

qualities such as determination or long-term persistence) and since these two factors are measured by his performance scale at 11 plus, the scores on the scale furnish a trustworthy index of the practical aptitude of a given child and of his likelihood to benefit from a secondary technical course of instruction.

Assuming for the moment that an individual's score in the practical factor is determinable at 11 plus, how important is this factor in determining success in the technical school curriculum? This question, it should be remembered, is as important if not more important than the question of determining the existence of F at 11 plus, for unless it can be shown that the factor is also one that enters significantly into the vocational and educational activities for which guidance is provided, its assessment even if possible can have but little value for educational practice. The results of one of Alexander's own groups may be profitably examined in this connexion. It will be recalled¹ that one of his groups (Group III) consisted of 103 boys from a technical school in Chicago, who in addition to being tested on the performance and other tests employed in the investigation had also scores in school achievement in Shopwork, Mechanical drawing, Mathematics, Science and English. Five factors were extracted from the data, namely, g (general intelligence), v (verbal factor), F (practical factor), X (persistence) and Z (some unidentifiable factor in character). The percentage of variance which each factor accounted for in the different subjects of the technical curriculum are reproduced in the following table.

TABLE I

Showing percentage of variance accounted for by various factors in different subjects in Alexander's investigation²

School Subjects	Percentage of variance accounted for				
	g	v	F	X	Z
Shopwork	10		13	43	34
Mechanical Drawing	16.5	4	4	75	
Mathematics	31	19		48	2
Science	12	31		55	
English	10	63		23	
Total	79.5	117	17	244	36
Average percentage of Variance	15.9	23.4	3.4	48.8	7.2

1. Alexander, W.P. "Intelligence, Concrete and Abstract". The British Journal of Psychology, Mon. Supplement, 19, 1935.

2. This table is derived from one of Alexander's tables given in his "Intelligence, Abstract and Concrete", p. 114.

It is clear from the table that of all the factors determining success in school subjects F is the least important. The only two subjects in which it does enter at all are Shop-work and Mechanical Drawing, and in these also it accounts for only 13 per cent and 4 per cent of the variance respectively. The values in the last row of the table which indicate the average variance accounted for by the different factors, in the 5 subjects taken together, make this even more apparent. X accounts for nearly half of the entire variance (48.8) and is alone, therefore, almost as important as all the other factors put together. v comes next and accounts for about a quarter of the total variance (23.4); g accounts for the next 15.9 and Z for only 7.2; F comes last and accounts for a very small percentage, namely, 3.4. As far as predicting success in the technical curriculum is concerned, therefore, the conclusions that seem to follow from the present analysis are :—

(1) It is most worthwhile to devise suitable tests of X (a character trait). As this factor accounts for nearly one half of the entire variance, any educational guidance procedure which overlooks the factor will run the risk of making recommendations on a very incomplete appraisal of the individual's important qualities.

(2) Since the factor next in importance is the verbal factor, it follows that as far as mental abilities as distinguished from qualities of character and temperament are concerned, its assessment would seem to be more essential than that of any other ability. It is rather surprising that v should come to play so important a role in school subjects of a technical curriculum.

(3) General intelligence seems to be important but not so important as it might have been expected. The remaining two factors Z and F are insignificant, particularly F which accounts for only a very negligible fraction of the variance (3.4).

Alexander's analysis further showed that the three performance tests had no loading in X and v; in other words they left about $\frac{3}{4}$ of the whole variance (72.4) entirely undetermined. The remaining three factors in which they showed loadings were g, Z and F which together accounted for about $\frac{1}{4}$ of the variance (26.5) only. In g which is the most important of the three factors, they were not as highly saturated as certain other tests as, for example, Spearman test 3 or Number-verbal test 2; in Z also the highest loading occurred in one of the Spearman's tests (test 2). The only remaining factor in which one of the three performance tests (Cube Construction) showed the highest loading (.704) was, therefore, F, a factor of such negligible importance that no serious harm could occur even if it were completely overlooked in an actual guidance programme. In view of these facts, whether educational guidance for technical courses of

instruction, in any effective sense of the term is possible on the basis of performance in Alexander's Scale may be seriously questioned.

Returning to the question of assessing practical ability at 11 plus, it is noted that Alexander's own evidence although relevant to a consideration of the factorial structure of his tests was not very relevant to this problem for all his groups consisted of older subjects. One of his groups was sufficiently young (mean age 142.4 months) for the purpose, but since sex was not controlled, little reliance can be placed on its findings. Alexander himself used the results of this group mainly in illustrating the statistical techniques employed in his investigation.

The main evidence in support of his views seems to be derived from the confirmatory researches carried out by Drew.

In a thesis (1944) lodged at Leeds University—"An Experimental Enquiry into the methods of selection for Technical Education based on Multiple Factor analysis", Drew is mentioned by Alexander¹ to have produced evidence that F was capable of measurement at the age of 11 plus. In a later research, Drew arrived at certain conclusions concerning the measurability of and relationship between F and k^2 at different ages and many other important matters regarding the allocation of children at 11 plus to different kinds of secondary education. His conclusions pertinent to the present topic were these. "...

(4) The performance scale, which has been shown to measure g and F at 11, correlates substantially with success in the Junior Technical School Diploma Examination...

(5) Selection of boys for technical education can be facilitated at 11 plus by using the performance scale as a measure of technical aptitude, in addition to tests of general and verbal ability. A certain degree of general ability and some minimum verbal ability are required as qualifying criteria, for admission to Technical Schools. Indication of technical aptitude, where marked, should be the determinant of direction...

(6) Allocation by type of ability as well as by degree can be carried out effectively, within certain limits, if results on the individual performance scale are obtained during the final year in the Junior School."³

-
1. Alexander, W.P. "Symposium on the selection of pupils...II, An Administrator's point of view," B.J.E.P., Vol. 17, 1947, p. 124.
 2. The symbol k was first employed by A.A. El. Koussy in 1935, to label a spatial factor for which evidence was reported by him in his study on visual perception of space. Since then the symbol has been generally used to represent this function.
 3. Drew, L. J. "An investigation into the measurement of technical ability," *Occup. Psychol.*, vol 21, 1947, pp. 43-44.

These three conclusions may now be examined seriatim. The first conclusion is a very weak conclusion indeed. Since the group in which the performance scale is shown to measure *g* and *F* at 11 plus and the group in which it is later shown to be significantly related to school Diploma Examination at 16 are different, it can be questioned whether the correlation coefficient obtained in the older group is a true measure of the accuracy with which performance scale scores obtained at 11 plus will predict subsequent achievement in the technical curriculum at 16. The only valid and satisfactory procedure to answer this question would consist in giving the performance scale to a group of 11 year old children and later to correlate it with their achievement in technical subjects after 4 or 5 years when there is reason to believe that the abilities and interests of children have sufficiently stabilised to make a final estimate of their performance possible.

Even granting that the correlation coefficient which Drew obtained in his 16 year old group is a measure of the extent to which performance scale measures technical aptitude, what is the size of this coefficient? On averaging the correlations between the three performance tests (Passalong, Kohs' and Cube Construction) and the four groups of school subjects of the technical curriculum (English, Science, Drawing and Shops), a value of .300 was obtained. The standard error of this co-efficient on a null hypothesis of independence is .107; in other words, the average correlation co-efficient between the performance tests and the school subjects is not even three times its standard error—certainly not a 'substantial' relationship! How much reliance could be placed on this co-efficient may be imagined by noting that if it were attempted to predict success in the criterion by means of a test of this type, the variance of the ultimate criterion scores for a given test score would be over 90 per cent of the variance which would be obtained if the test evidence were not available. What would be the relationship between performance on this scale as a whole and the technical criterion as measured by combining scores in all the four groups of the school subjects to the best advantage cannot be ascertained, for Drew reported no figures on the matter.

The second conclusion (5) is very reasonable in appearance, since all that it says is that in the case of those few children who are exceptionally good at the performance scale and only moderately good in general intelligence and verbal ability, a decision in favour of their receiving secondary technical education may be taken. However, the experimental data reported by Drew in his article are not directly related to this recommendation. Consequently without making further detailed statistical analysis of his findings regarding the number of cases that this recommendation is justifiably going to affect etc. it is not possible to estimate the exact value of the suggestion. Seemingly, it will affect only a few cases, thus leaving educational decision in the case of the vast majority quite undetermined.

The last conclusion is, again, unwarranted, due to the objections raised against the first conclusion which are also valid here. There is, however, an additional flaw in this conclusion. Since none of the groups studied by Drew was tested by him during the final year in the Junior School, the conclusion is purely an expression of opinion unsupported by any experimental data.

In addition to these criticisms, it may be mentioned that Drew's findings regarding the measurability of practical ability at 11 plus have been criticised by other investigators on several important grounds. Bradford, for example, thinks that Drew's data are not very reliable, owing to the fact "...that the performance testing on the two younger groups of pupils was largely carried out by Training College students hardly out of their teens and not by a responsible psychologist..."¹ Slater has further shown that the factorial results obtained by Drew do not fit the data from which they are derived. He also thinks that "...there are certain findings which are so extraordinary that one is forced to doubt whether they have been correctly recorded."² In view of the fact that Drew has not replied to these criticisms, not much significance need be attached to his evidence that practical ability is measurable at 11 plus as well as to his other findings.

Earle also believes that "Provided that we take the trouble to study properly the mental processes involved, we need have no difficulty in making reasonably reliable forecasts at 11 plus regarding the probable progress and achievement of individual pupils and in basing our classifications upon these forecasts."³ Earle's conviction regarding the possibility of effective classification of children at 11 plus seems to be based among other things on the satisfactory results yielded by his "Duplex Test" in allocating school children during the first year of their secondary school courses to different types of secondary curricula in a certain multi-lateral school⁴ of which he was the principal for eighteen years. This test according to its author serves a dual purpose. On the one hand the total score serves as an index of the general ability of the child; on the other hand, the scores in the component parts give separate measures of the child's ability to use words, to recognize or describe attributes, to recognise and employ processes involving relations of number and space etc. and thus provide useful information regarding the relative strength of the various abilities (such as linguistic ability, practical ability, etc.) employed by him in his school work.

-
1. Bradford, E. J. G. "Symposium on the selection of pupils...IV—An experimenter's point of view" B. J. E. P., Vol. 18, 1948, p. 69.
 2. Slater, P.—"Evidence on selection for Technical Schools," *Occup. P.*, Vol. 21, 1947, p. 140.
 3. Earle, F. M. "The significance of ability differences at eleven plus", *Occup. Psych.*, Vol. 21, 1947, p. 195.
 4. Krikcaldy High School, Fife.

Earle's evidence is of value, especially because it comes from "... a practical schoolmaster who has been engaged in classifying and advising secondary pupils according to their abilities and interests for a long time."¹ However, there are one or two considerations which seem to detract to some extent from the force of his conclusions. In the first place, the evidence in question relates to children of 12 years of age and not to children of 11. Earle says that his tests gave satisfactory results even with children of 11, but he reports no actual evidence in support of his claim. Secondly, the allocation of children to different secondary departments in Earle's multilateral school seems to have been largely determined by a consideration of the level of their general and verbal ability only and not by a systematic assessment of all the aptitudes involved. Lastly Earle seems to take proficiency in mathematics and science as an adequate index for practical ability. No doubt success in these subjects seems to be necessary for achievement in highly technical professions and that is probably the main reason why a considerable amount of time is devoted to these subjects in the technical school curriculum; but it is doubtful if practical ability and the ability to excel in these subjects are co-extensive. Science and Mathematics as usually taught in schools seem to be of an abstract character and for that reason to be more related to general intelligence and verbal ability than to practical ability. That is also the explanation suggested by Alexander as to why he failed to get any F loading in science and mathematics in his investigation.

In a factorial study which was designed partly to throw light on the theory of "abstract" and "practical" types "but mainly to see whether any emergence or growth of abilities could be deduced from the results of a battery of tests given to a complete age group of boys, at six monthly intervals between the ages of 11½ and 13½", Dempster gave to his group four tests of a verbal nature, four spatial tests (Space Perception, Form Relations, Memory For Designs and Tracing) and a verbal and a non-verbal test of general ability. The results were analysed by the centroid method and upon each occasion three factors emerged, a general factor followed first by a bipolar factor differentiating between abstract or verbal tests and concrete or non-verbal tests, and then by a third factor, also bipolar, that seemed to contrast the "Reasoning" tests with (what Dempster calls) the "Appraisal" tests. Dempster concluded: "The abilities associated with verbal and spatial work seem to be maturing at comparable speeds during these years. This conflicts with the statement made by Burt and others that the ability associated with spatial tests either "emerges" after the age of 11 or matures more rapidly after that age and thus can be more easily measured

1. Earle, F. M. op. cit., p. 195.

at 13 than at 11."¹ Bradford also conducted an experiment to ascertain the value of certain new principles of selection for grammar and technical schools. Using a test-population of 120 primary school children, 11 years of age, he arrived at the following conclusion: "Though no completely satisfactory proof of the existence, at the age of 11 years, of marked differences between success at verbal and practical tests may have been published, the results obtained...suggest that measurable differences may be expected among pupils of 11 years of age, *if their mental age is at least 12 years*"². In other words, Bradford's conclusion implies that the likelihood of benefitting from secondary technical education can be determined at 11 only in the case of those children whose I.Q. is 109.1 ($12/11 \times 100$). Taking 15 points of I.Q. as the standard deviation of intelligence in a normal 11 year group, this means that the practical ability of only those children is determinable at 11 who are at least, $.61 \sigma$ ($9.1/15$) above the mean. Since only 27.1 per cent of the total population will meet the requirement, it further means that in the case of the majority of children (72.9 per cent) the decision concerning the suitability of secondary technical education for them cannot be taken at 11. It should be admitted, however, that since children suited to secondary technical courses of instruction are generally supposed to be of more than average intelligence, the top 27.1 per cent of the total population in whose case Bradford thinks that practical ability is measurable at 11, may include a good proportion of the total number of children suited to technical education in the whole population.

If the evidence produced by Bradford, Dempster and others were supported by the findings obtained by other investigators, there could be no objection against the acceptance of the feasibility of selection of children suited to a secondary technical course of study at 11 plus. As it is, however, not only do the studies carried out by other investigators fail to support their findings, but the general opinion of the teachers and psychologists also seems to be against the possibility of any scheme of effective classification at this age. This evidence must now be presented. Before giving the results of the experimental investigations, the opinions of the psychologists and technical school teachers may be stated first. This sort of evidence is very important as it is based in many cases on a life-long contact with the actual problems of children each faced with the question of choosing from among a number of alternative courses of instruction the one which suits his or her ambition, interests and ability

1. Dempster, J.J.B. "Symposium on the selection of pupils for different types of secondary schools, V, the Selector's point of view," B.J.E.P., Vol. 18, 1948, p. 125.
2. Bradford, E.J.G. op. cit, p. 83.

most. The kind of evidence obtained from factorial studies, on the other hand, is in most cases based on data collected by giving a few tests supposed to measure certain hypothetical abilities, to small samples of children (rarely exceeding 150) on some particular occasions. Moreover such evidence relies in the end on the subjective identification of certain factors found from analysis of different groups. It is debatable whether factor-analysis can ever identify factors as mental entities, which inter-group comparisons would seem to imply.

Burt gives several important reasons against the classification of children to different secondary courses at 11 plus. In the first place he thinks that special abilities (such as the verbal ability, mathematical ability, and practical, manual or mechanical ability) begin to emerge into prominence only towards puberty and, therefore, any assessment made earlier than that age (that is, 13 or 14) is likely to be falsified by the subsequent mental development of the child. Secondly, in his opinion, these special abilities are so largely determined by opportunity, experience and interest, that their assessment at an early age like 11 plus may not possess much significance in relation to the later development of the functions.

Another objection which Burt raises in this connexion relates to the *measurability* of practical ability at 11 plus. He thinks that success in tests of practical ability such as the Alexander's Scale, which are intended to estimate the practical aptitude of children at so early an age as 11 plus is determined more by the subject's level of general ability than by special aptitude. Our own factorial evidence supporting Burt's views is cited at the end of this discussion (p. 11). Burt further emphasises that the educational future of children should not be decided exclusively in the light of the assessment of their abilities and aptitudes; it is necessary to take into account the make-up of the whole personality and character. For success in the educational and later in the vocational sphere, he points out, is not merely a function of one's cognitive dispositions; factors relating to temperament and character also play a most determining role. He further suggests that a proper estimation of the present and future circumstances of a child should also be a relevant consideration while giving him educational guidance. Parenthetically, this sociological consideration of the present and future circumstances of the subject seems, in the opinion of the present writer, to have been rather overstressed by Burt. If a child possesses the abilities and necessary character qualities to follow a certain educational career, ultimately leading to a profession not entirely in line with the status and traditions of his family, it may not always be right to dissuade him on sociological grounds, from adopting the course in question.

Similar doubts concerning the measurability of technical ability at 11 plus are also expressed by Rodger who has had a long experience in dealing with problems of educational and vocational guidance. The Report of the Joint Committee of the Association of Technical Institutions and the Association of Principals of Technical Institutions, under the Chairmanship of Mr. M. W. Garside, on "Testing for the Secondary Technical School" summarised Rodger's evidence to the Committee thus: "(He)* felt that no psychological tests either at 11 or any other age had been successful enough in selecting pupils for technical education to warrant their confident use, although he believed that many tests could be found which isolate the 'very good' from the 'very bad' candidates."¹ The general opinion of the technical school teachers also agrees with that of Burt and Rodger. There are many children, they say, who do not show any conspicuous indications of practical ability at 11 plus but who later distinguish themselves in their work at technical schools. For this reason, the technical school teachers have, on the whole, been quite content with the past selection arrangements which fixed the age of entry to junior technical schools at 13 plus.²

From a review of these expert opinions on the subject of selection, we may now pass on to a consideration of four experimental investigations, three of which were carried out by Slater and the fourth by the author himself, in order to contribute further evidence on the issue of the measurability of technical aptitude at 11 plus.

Slater³ tested 82 children from a junior school at Willesden during the year they were due to take their Special Places Examination. The tests employed were, two tests of spatial judgment (Figures Construction and Squares), a new non-verbal intelligence test in four sections (N.I.I.P. Group Test 70) used as a control test and a standard verbal intelligence test. The results were analysed by the Thurstone technique and the Spearman method. Both analyses revealed a general factor running through all the tests and a verbal factor confined to the four sections of the verbal test (Classification, Analogies, Completion and Miscellaneous Problems). There was no evidence for a spatial factor; the two spatial tests proved to be pure measures of general intelligence.

-
1. Quoted from P. Slater's article "Evidence on selection for Technical schools", referred to earlier on page. 6.
 2. The evidence is borrowed from P. Slater's article "Tests for selecting secondary and technical school children, "Occup. p., Vol. 15, 1941, p. 24.
 3. Ibid.

* The bracket is the present writer's.

In the second¹ of Slater's experiments a group of about 400 11 to 12 years old children from Oxford were tested on the following tests:

(1) A non-verbal intelligence test (N.I.I.P. Group test 70) to control the variations attributable to general intelligence.

(2) A verbal test of intelligence constructed specifically with a view to controlling variations due to verbal ability.

(3) A set of four special tests, namely, the Square Test, the Recognition of Designs Test, the Shapes Test and the Spatial Test (in four sections).

In his third² experiment about 200 children (boys and girls) of secondary school age (13 to 14) were tested. In addition to the tests used in the preceding experiment, a Progressive Matrices test was also added to provide a further control on variations due to intelligence. The results of both these experiments were investigated by Thurstone's method of factor-analysis and in each case two factors—a general and a verbal factor—appeared sufficient to account for all the correlational variations presented by the data. In neither case was there any evidence for postulating any spatial factor common to the spatial tests used in the two investigations. The results of all the three experiments conducted by Slater agree, therefore, in denying evidence for a spatial factor in the group of subjects studied. (Slater's interpretations have been recently questioned by Adcock³ who subjected the former's data to the new Thurstone Multiple group method and several other methods such as the cluster analysis, and reported evidence for a k factor which in both of Slater's analyses was (according to Adcock) hiding away under the reported general factor. He concluded that the seeming absence of the k factor in the original analyses was attributable to the assumption that g must always appear in addition to the group factors⁴).

In the factorial study carried out by the author six well-known tests of practical ability and two tests of general intelligence—one verbal and the other non-verbal—were applied to a homogeneous group of 120 children from four primary schools in the East End of London. The mean age of the children

1. Slater, P. "The development of spatial judgment and its relation to some educational problems", *Occup. P.*, Vol. 17, 1943, pp. 139-155.
2. *Ibid.*
3. Adcock, C. "A re-analysis of Slater's spatial judgment research," *Occup. P.*, Vol. 22, 1948, pp. 213-216.
4. In the opinion of the present writer, however, the assumption that g must always appear in addition to the group factors, does not seem very unnatural especially when one is dealing with young children. He accepts, therefore, Slater's own interpretation of his results.

was 10 years 9 months. The tests used were: (1) The Passalong Test (W.P. Alexander) (2) Kohs' Block Design Test (3) The Cube Construction Test (4) Vincent Mechanical Models Test B (National Institute of Industrial Psychology, London) (5) Form Relations Group Test (N.I.I.P.) (6) Memory for Designs Test (N.I.I.P.) (7) Group Test 36 (N.I.I.P. Verbal test of intelligence) and (8) Group Test 70/1 (N.I.I.P. Non-verbal test of intelligence.)

The test intercorrelations are given in the matrix below. Figures in the parentheses are the standard errors of the co-efficients.

Table 2. Showing the original Correlational Matrix.

Test	2	3	4	5	6	7	8 (70/1)
1. Pass.	.284 (.084)	.188 (.088)	.204 (.090)	.217 (.087)	.229 (.087)	.154 (.090)	.158 (.089)
2. Kohs'		.595 (.068)	.435 (.074)	.495 (.069)	.518 (.067)	.193 (.088)	.535 (.066)
3. C. Cons.			.372 (.079)	.410 (.076)	.419 (.076)	.185 (.089)	.357 (.080)
4. V. Models				.598 (.059)	.420 (.076)	.220 (.087)	.314 (.083)
5. F. Relations					.539 (.065)	.147 (.090)	.397 (.077)
6. M. Designs						.195 (.088)	.401 (.077)
7. Verbal 36							.430 (.075)

The method of factor-analysis chosen was Thurstone's centre of Gravity Method. The choice of this method was determined partly by the relative simplicity of the calculations involved but mainly by the fact that in most of the earlier factorial investigations on practical ability, the method of analysis employed was Thurstone's. With a different technique of factor analysis, the evidence of the present study would not have been, strictly speaking, comparable to the findings of the earlier investigations.

It may be mentioned here that this factorial investigation was not designed independently, but resulted from the data of another study which was carried out with a view to determining the reliability of the eight tests mentioned above. As

such, there are certain defects in the present experimental design which under the circumstances could not be helped. For instance, the number of tests used is only 8, a number too small to warrant any definite conclusions and which enables not more than 4 psychologically meaningful common factors to be found. Also, the number of tests representing each of the possible factors in the study is very small. Excepting the three performance tests (1, 2, 3) which in view of Alexander's research may be supposed to possess similar factorial structure in terms of g and F , there is only one verbal test representing a possible verbal factor (7), only one test of mechanical ability (4) representing a possible mechanical factor and only two tests (5 and 6) representing a possible spatial or k factor. (This would imply the possibility of 5 primary factors, g , v , F , m and k). Then again, the number of the group tested is only 120, a number too small for a confident identification of the factors involved. In view of these limitations the tentative nature of the findings to be reported cannot be gainsaid.

Though it was realised that the factors were probably not all meaningful, five were extracted in case the five factors named above could be found to be present. After each extraction, the diagonal cells were filled by the highest co-efficients in the columns concerned as estimates of the test communalities. The loadings of the five factors are shown in the table below.

Table 3. Showing centroid loadings of the five factors.

Test	I	II	III	IV	V	h^2
Pass.	.358	.088	.189	-.187	.103	.217
Kohs'	.729	.041	.219	.239	.149	.660
C. Cons.	.613	-.055	.200	.111	-.144	.451
V. Models	.659	-.271	-.118	-.149	.149	.565
F. Relations	.708	-.348	-.155	.102	.200	.697
M. Designs	.679	-.138	.029	.143	-.072	.507
Verbal 36	.407	-.347	-.263	-.181	-.111	.400
Non-verbal 70/1	.651	.351	-.179	.251	.040	.644
Percentage of variance contributed by each factor	37.7	5.9	3.3	3.2	1.7	

In view of the fact, however, that not a single residual after the extraction of the second factor was even twice the size of the standard error of the original correlation co-efficient, it is highly probable that none of the last three factors is significant. The extreme smallness of the second factor residuals further obviated any need of applying some test such as Burt's Chi-square test to determine the number of significant factors. The second factor residuals are described in the table below.

Table 4. Showing second factor residuals. Figures in parantheses are the standard errors of the original correlations.

Tests	2	3	4	5	6	7	8 (70/1)
1. Pass.	.020 (084)	.026 (088)	.008 (090)	.006 (087)	.002 (087)	-.023 (090)	-.106 (089)
2. Kohs'		-.061 (068)	.033 (074)	.007 (069)	-.029 (067)	-.118 (088)	.046 (066)
3. C. Cons.			-.046 (079)	-.043 (076)	-.005 (076)	.046 (089)	.022 (080)
4. V. Models				.038 (059)	-.065 (076)	-.046 (087)	.019 (083)
5. Form Relations.					.010 (065)	.020 (090)	-.058 (077)
6. M. Designs						.033 (088)	-.008 (077)
7. Verbal 36							.043 (075)

On a basis of stopping factoring when not more than 5 per cent of the residuals exceed twice the size of their standard errors, the existence of even the second factor seems to be in doubt. However, as the factoring of the first residual matrix gives several loadings exceeding .3, the figure customarily taken for a significant loading in a group of this size, the second factor was retained. The centroid factor loadings of the two factors are shown in the table below.

Table 5. Showing unrotated centroid factor loadings.

Test	I	II	h^2
1. Pass.	.358	.088	.136
2. Kohs'	.729	.041	.533
3. C. Cons.	.613	-.055	.378
4. V. Models	.659	-.271	.507
5. F. Relations	.708	-.348	.623
6. M. Designs	.679	-.138	.480
7. Verbal 36	.407	.347	.286
8. Non-Verbal 70/1	.651	.351	.547
		.827	
		-.812 .015	

It is commonly believed that the centroid axes usually lack psychological meaning; it was, therefore, considered necessary to rotate the axes into a simple structure. Thurstone himself is very emphatic on the point of rotation and writes, "No matter how the correlational matrix is factored, the axes must be rotated into a simple configuration before any psychological interpretation can be made. The frequent attempt to find psychological interpretation for the centroid axes without rotation, and for the principal components without rotation, are examples of this error."¹

The rotation of the centroid loadings into simple structure requires

"(1) That all factor loadings should be positive within the limits of sampling errors and (2) that there should be as many zero loadings as the configurations of points will permit."²

1. Thurstone, L.L. "Current misuse of the factorial methods", *Psychometrika*, vol. 2, 1937, p. 74.
2. Guilford, J.P. *Psychometric Methods*. McGraw-Hill Book Company, Inc., New York and London, 1936, p. 476.

The angle of rotation required for the centroid axes in conformity with the above two conditions was found to be $63^{\circ}, 50'$ in the anti-clockwise direction.¹ The required transformed factor loadings were then obtained by applying the formula,

$$k'_1 = k_1 \cos \phi + k_2 \sin \phi$$

$$k'_2 = k_2 \cos \phi - k_1 \sin \phi \text{ where}$$

k_1 and k_2 = the original centroid loadings for factors I and II.

k'_1 and k'_2 = the new factor loadings after rotation of the centroid axes.

ϕ = angle of rotation"²

The following table gives the factor loadings before and after rotation.

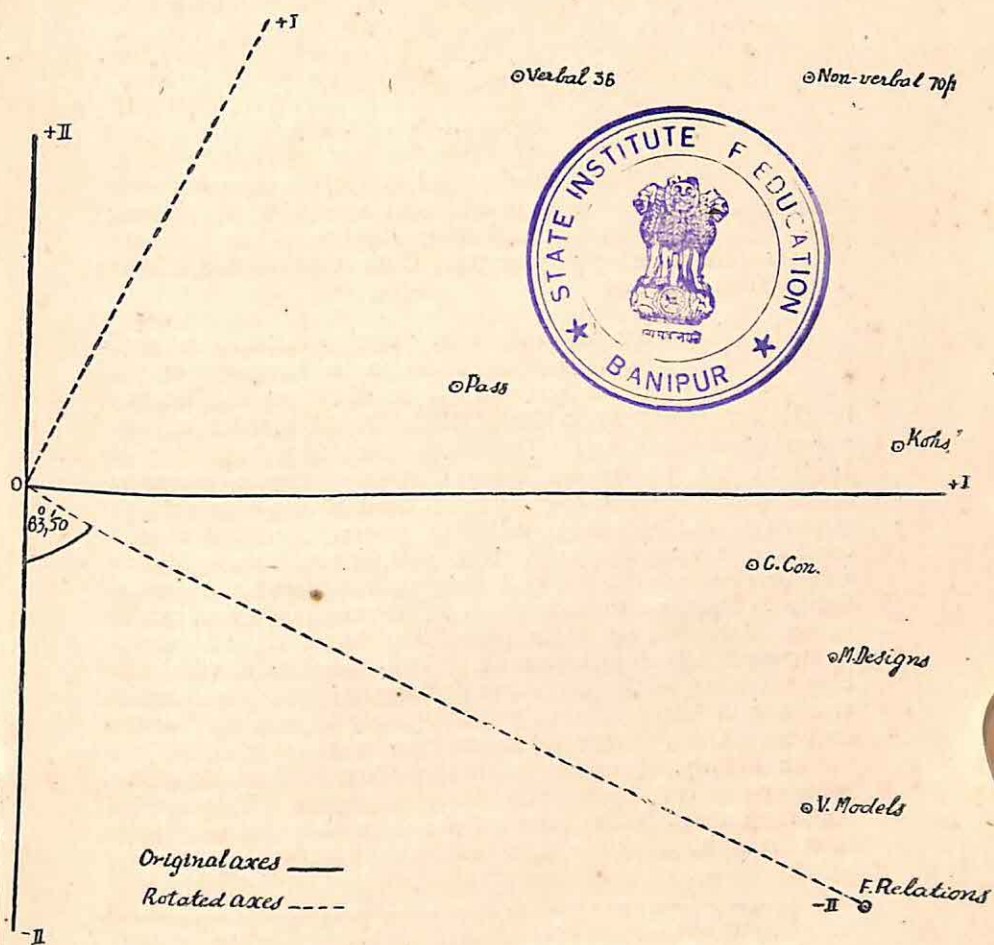
Table 6. Showing centroid factor loadings before and after rotation.

No.	Test	I		II		h^2
		Unrotated	Rotated	Unrotated	Rotated	
1	Pass.	.358	.237	.088	.282	.136
2	Kohs'	.729	.358	.041	.636	.533
3	C. Cons.	.613	.221	-.055	.574	.378
4	V. Models	.659	.047	-.271	.711	.507
5	F. Relations	.708	.000	-.348	.789	.623
6	M. Designs	.679	.175	-.138	.670	.480
7	Verbal 36	.407	.491	.347	.212	.286
8	Non-verbal 70/1	.651	.602	.351	.429	.547

1. See Figure on p. 17.

2. Guilford, J.P. Op. cit., pp. 489-490.

ROTATION OF CENTROID FACTOR LOADINGS



A study of the table, however, reveals that the unrotated loadings are easier to interpret than the rotated ones. Assuming, for example, that there is a general factor in all the tests, the rotated first factor loadings would contradict that assumption in the case of Form Relations, Vincent Models and to a certain extent in that of Memory for Designs. Under these conditions, the writer suggests that interpretation be confined to the unrotated factors alone, where in any case the first factor may be considered to have an identity as a general factor in the sense Burt uses the term. In the following interpretation only the unrotated factor-loadings are being considered.

FACTOR I

Interpreting this as the general factor, the saturations are positive in all cases and in order of size rank as follows: Kohs' Block Design, Form Relations, Memory for Designs, Vincent Models, Group Test 70/1, Cube Construction, Group Test 36 and Passalong.

Kohs' opinion about his test, namely, that it is a good measure of general intelligence seems to be borne out by the findings of the present research. Form Relations and Memory for Designs rank next to Kohs' Block Design in order of their general factor saturations. This seems to confirm the finding of Line¹, Fortes², Clarke³ and others that tests of space-perception are effective measures of *g*. Vincent Models also shows a high saturation and seems to call for general intelligence to a considerable extent. Group Test 70/1 follows Vincent Models and does not seem to be as highly saturated with the general factor as Slater's own description of the test might lead one to expect. Group Test 36 is placed last but one and shows an unexpectedly low saturation. This combined with the high reliability of the test strongly suggests that the factorial structure of the test is only incompletely represented in the analysis. This was expected since there is no other verbal test in the battery. Passalong is the last test in the rank with a saturation of only .358 in the factor in question. This coupled with the author's finding reported elsewhere that the test is the most unreliable of all the tests studied implies that the test is not suitable for use with children of this age.

-
1. Line, W. "The growth of visual perception in children", *The British Journal of Psychology*, Mon. Supp. 15, 1931.
 2. Forte, H. "A New Application of the Theory of Neogenegsis to the Problem of Mental Testing", 1930, Ph.D. thesis in the London University Library.
 3. Clarke, G. "The Range and Nature of the Factors in Perceptual tests", 1937, Ph.D. thesis in the London University Library.

FACTOR II

The bi-polar factor has positive loadings in the case of Group Test 36 and 70/1, Passalong and Kohs' Block Design ; and negative in the case of Form Relations, Vincent Models, Memory for Designs and Cube Construction. The loading in the case of Passalong, Kohs' Block Design and Cube Construction are too small to merit serious consideration. The loadings in the case of the Group Tests 36 and 70/1 are not only positive but also numerically the highest, suggesting, therefore, that the factor resides with these two non-spatial-tests. It is rather curious that Group Test 70/1 aligns itself with Group Test 36, for according to Slater's description the test is at least as much non-verbal as it is non-spatial. In a bipolar situation, such as the present one, the test could have been more naturally expected to side with the spatial group of tests, since introspective analysis of the mental activity called for in answering this test seems to suggest that the test performance does involve a spatial element, however inconspicuous.

It is to be rather regretted that the nature of the present evidence does not allow a very clear interpretation of the factor in question. In investigations of this kind, non-general and non-spatial factors (that is, factors with negative or insignificant loadings in spatial tests) are usually interpreted in verbal or symbolic terms. The presence of the factor in Group Test 70/1, however, makes such an interpretation impossible. The only significant point in which Group Tests 36 and 70/1 seem to differ from Form Relations, Memory for Designs and Vincent Models is that while response in the former follows quickly upon the perception of the problem, in the latter it tends to be much slower on account of the thinking or mental manipulation involved. It is proposed to name this factor as "Perceptual Speed". The interpretation is, however, rather speculative and would need further confirmation.

A word may be added here about the importance of the general factor. A study of Table 3 reveals that while the first factor accounts for 37.7 per cent of the variance, all the other factors together account for only 14.1 per cent. This means that not only is the first factor far more important than the second (perceptual speed, accounting for 5.9 per cent of the variance), but also than all the others combined. The finding is in agreement with Burt's¹ view that the educational performances of children of 11 years of age are largely determined by a general factor, which accounts for 30 to 50 per cent of the variance, the more specialised group factors accounting together for about 10 to 20 per cent of the variance only. The finding of the present research is further in agreement with

1. Burt, C. "Symposium on the selection of pupils...I, General Survey," B.J.E.P., Vol. 17, 1947, p. 60.

Vernon's¹ report that in seven typical factor analyses carried out during the war in the British Navy and the Army, the *g* factor obtained $2\frac{1}{2}$ times the variance of the other factors combined. In the present study the general factor obtained about 2.7 times the variance of the other factors combined.

The main facts of the present factorial study may now be summarized.

1. There is evidence for a general factor which seems to account for most of the variance in question.

2. There is some evidence for a bipolar perceptual-speed factor. On account of the fact, however, that it accounts for only 5.9 per cent of the variance, it is suggested that not too much significance should be attached to its existence in the analysis. The fact that none of the first factor residuals were significant, as judged from the criterion of even twice the standard errors of the original correlations, would even suggest that the factor may to some extent be a product of sampling fluctuations. McNemar's study would strongly support this possibility².

3. Since the second factor appears to reside with the non-spatial rather than the spatial tests, it may be concluded that as far as the evidence of the present research is concerned, *there is no evidence for a spatial or practical factor*. The finding is in agreement with the finding of Slater reviewed earlier (p. 11),

4. As far as the three performance tests used in this study are concerned, it may be concluded with a high degree of confidence, that since the second factor loadings in all the three tests are extremely small, the factorial structure of these tests seems to be more or less exclusively determined by the general factor. This contradicts the claims of Alexander and Drew regarding the existence of a practical factor at this age. The evidence supports Burt's view that, when used with young children the tests in question are mostly measures of general intelligence.

5. Since the performance tests used in this study are measures of general intelligence only, their use with young children cannot be justified on account of the heavy time expenditure involved in their administration. The same object can be achieved equally well by employing suitable group tests. This is in agreement with the recommendations made by Price³ and Harrell⁴ regarding their adult subjects.

-
1. Vernon, P.E. "Research on personnel selection in the Royal Navy and the British Army", *The American Psychologist*, Vol. 2, 1947, p. 39.
 2. McNemar, Q. "On the sampling errors of factor loadings", *Psychometrika*, Vol. 6, 1941, pp. 141-152.
 3. Price, E.J.J. "The nature of the practical factor (F)", *British Journal of Psychology*, Vol. 30, 1940.
 4. Harrell, W. "A factor analysis of mechanical ability tests," *Psychometrika*, Vol. 5, 1940, p. 27.

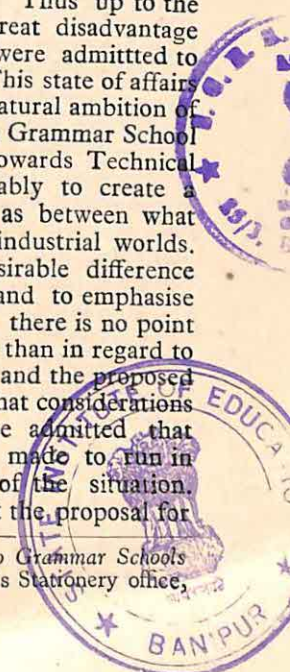
6. The group tests of space-perception employed in this study measure general intelligence effectively. In this respect they seem to be even more effective than the verbal tests. This conclusion is in agreement with the earlier conclusions of Line, Fortes and Clarke regarding the nature of abilities sampled by different kinds of group tests of space-perception.

In brief, therefore, as far as the question of the measurability of practical ability in young children is concerned, the factorial results of the present investigation support Slater's conclusions regarding the absence of the practical factor at 11 plus.

Before concluding the evidence on the measurability of practical ability at 11 plus, however, it may be recalled that the recommendation that the age of entry to technical schools should be 11 plus instead of 13 was first made in the United Kingdom by the Spens Committee in 1939. But if one studies the Spens report carefully, he will find that the considerations which prevailed with the committee in making the recommendation were for the most part non-psychological. Some of the considerations, in their own words, were these "The Grammar Schools have hitherto secured the majority of the more gifted pupils from the primary schools by means of the selective examination at the age of 11 plus. Secondary schools of other types, more especially selective Modern Schools, have secured those candidates on the examination list who were not able to gain admission to Grammar Schools. Thus up to the present the Technical Schools have been at a great disadvantage in respect of the quality of the pupils who were admitted to them at the age of 13+..."¹ And further "This state of affairs has had a serious social consequence. The natural ambition of the clever child has been turned towards the Grammar School and the professional occupations rather than towards Technical High Schools and industry. This tends inevitably to create a disproportion in the distribution of brain power as between what may be broadly termed the professional and industrial worlds. Furthermore, there is the regrettable and undesirable difference in social esteem. We are concerned to secure and to emphasise the parity of all types of secondary school but there is no point at which this is sociologically more important than in regard to the relative position of the Grammar Schools and the proposed Technical High School"². It cannot be denied that considerations such as these are important; it will also be admitted that administrative machinery cannot always be made to run in accordance with the psychological requirements of the situation. Nevertheless, it is necessary to recognise that the proposal for

1 & 2. *Secondary Education with Special Reference to Grammar Schools and Technical High Schools*, His Majesty's Stationery office, London, 1938, pp. 273-274.

26.2.2008
13071



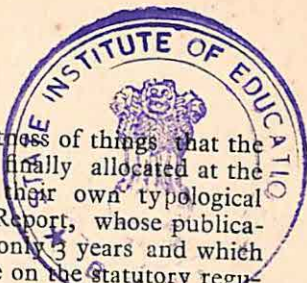
this administrative innovation of altering the age of entry to secondary technical schools from 13 to 11 plus is based on considerations of social and administrative convenience and not at all on any sound psychological facts relevant to the situation.

To say the least, the psychological evidence bearing on the measurability of practical ability at 11 plus is highly conflicting. Until some more conclusive evidence is forthcoming, the issue concerning the possibility of selection for secondary technical schools at 11 plus must be regarded as an open question. Meanwhile the views of the psychologists and the technical school teachers mentioned earlier serve to warn us of some of the dangers that a premature scheme of classification may involve.

We may next examine two important assumptions—one concerning the types into which children are supposed to be classifiable and the other concerning the inborn nature of general ability and special aptitudes which so often seem to underlie the proposals for selection of children for different forms of secondary education at an early age.

Types of Children

Proposals for allocating children at 11 plus to different kinds of secondary education often postulate that children belong to different types and that they remain true to their types. Of course, a practical scheme for classification of children into various groups studying different courses of instruction need not necessarily assume typological differences in the subjects; its justification may well lie in a given practical necessity such as that in a highly complex civilization like ours, a certain number of people must be set apart to specialise in the execution of highly technical jobs regardless of whether individual differences in aptitudes exist or not. But it makes a good deal of difference to know whether a particular scheme of classification is being adopted merely on account of the practical requirements of the situation or whether it is an inevitable consequence following from the marked native differences in ability and aptitude as exemplified by the subjects concerned. If the former is the case, not too much respect need be shown to any current classificatory tradition whether in the field of education or elsewhere. If, however, the latter is true, there may be some justification for care shown at the earliest opportunity in pigeon-holing individuals strictly in accordance with their class-attributes, as then such classification would be in the interest of their own happiness and development of abilities and aptitudes. The reason why in the opinion of the writer the framers of the 1944 Act in England and Wales seemed to have assumed that children belong to different types is suggested by the emphasis put on the terms "Ability" and "Aptitude" in the text of the Act. It is probable that the argument which guided the administrators in framing the Law was that since children possess different kinds



of ability and aptitude, it is only in the fitness of things that the secondary education to which they are finally allocated at the age of transfer be in accordance with their own typological characteristics. Nor does the Norwood Report, whose publication preceded the passing of the Act by only 3 years and which apparently exercised considerable influence on the statutory regulations leave us in doubt about the matter. The report distinguished between three types of children thus :

1. "...the pupil who is interested in learning for its own sake, who can grasp an argument or follow a piece of connected reasoning . he is interested in the relatedness of related things, in development, in structure, in a coherent body of knowledge .."¹

2. "...the pupil whose interests and abilities lie marked ly in the field of applied science or applied art... He often has an uncanny insight into the intricacies of mechanism, whereas the subtleties of language construction are too delicate for him".²

3. "...The pupil in this group deals more easily with concrete things than with ideas. He may have much ability, but it will be in the realm of facts ..he is interested only in the moment, he may be incapable of a long series of connected steps ; relevance to present concerns is the only way of awakening interest, abstractions mean little to him .."³

It was further expressly stated in the report that the first two kinds of pupils are those for whom the grammar school and technical school types of education are suitable respectively. No type-name was given to the third kind of pupil, but it was implied that the education likely to be suitable for him is that available in the senior schools (now secondary modern).⁴

Typological thinking is a very ancient mode of thinking and there is neither space nor time to enter into its history or the discussion of the various forms it has taken. Suffice it to say that even the most cherished typological theories (such as the extraversion-intraversion theory of Jung) have been found to be extremely artificial and simplified in their estimation of the observable variety and variability which seem to be exhibited in human personality considered emotionally, intellectually or from any other angle.

There is, however, one research by Dempster which was particularly designed to throw light on the question of types in

1. *Curriculum and Examinations in Secondary Schools*, His Majesty's Stationery office, London, 1943, p.2.
2. *Ibid.* p. 3.
3. *Ibid.* p. 3.
4. For different meanings of the term 'type' and history of typology see W. H. Hammond's 'Factorial Analysis in the Study of Types', 1941, M.Sc. thesis in the University of London Library. See also in this connection "A Statistical Study of Physical and Mental Types", by I. Cohen, 1940, Ph.D. thesis in the University of London Library.

school children. The exact purpose of the experiment was 'to describe and compare groups of secondary (now secondary grammar) and senior (now secondary modern) school boys in terms of estimated factor scores.' Fifty two secondary school boys and 43 senior school boys who had entered their respective schools only four months earlier, were given a battery of 28 tests intended to measure, among other things, verbal, reasoning, memory and spatial abilities, the tests calling for spatial ability being the N. I. I. P. tests for Space Perception, Form Relations, Memory for Designs and Tracing. The intercorrelational data were analysed by the centriod method; three factors being interpreted before and four after the rotation of axes. Necessary regression equations were calculated to give estimates of rotated and unrotated factor scores for each individual. The main conclusion arrived at in the research was that "... (the estimated factor scores)¹ showed that the population as a whole tended towards an even mental development, and that the general factor for the battery almost exactly divided the population into the Secondary and Senior groups of which it was composed... An examination of the profiles constructed from the estimated factor scores for each individual, showed that there were no definite "types" ... Except for the classification by the general factor for the battery, those suggested by the estimated scores for the other factors did not conform to the present grouping, but suggested sub-groupings within both the Secondary and Senior groups".² It might be added here that the inclusion of a comparable group of junior technical school boys in the same experiment by Dempster would not have been a very desirable matter, for the technical group would have been inevitably older than the secondary and senior groups by at least two years and thus would have adversely affected the homogeneity of the population as a whole. Dempster confirmed the findings of this experiment by carrying out another investigation which was described earlier (page 7).

Dempster's conclusions accord with the criticisms which Thorndike advanced against multiple type theories as long ago as 1914. He wrote: "There are no sorts or types of minds that stand out clearly as birds, fishes and worms do amongst animal forms.. Instead of a few 'pure' types or many 'mixed' types, there is one type 'mediocrity' supplementary types are invented to help out the discrepancies between the imagined types and the real distribution of individuals."

1. The bracket is the present writer's.

2. Dempster, J. J. B. "An Investigation into the Use of Estimated Factor Scores in Describing and Comparing Groups of Secondary and Senior School Boys of 11 Plus", 1944, M.A. thesis in the London University Library, p. 129.

Concerning the inborn nature of General Ability and Special Aptitudes

A second assumption related to, in fact implied in the first assumption is to the effect that differences in ability and aptitude are mostly inborn, for unless the assumption is granted, measures of these functions will be under no great necessity to remain constant and may later falsify any classificatory scheme adopted at II plus.

As regards general ability, the assumption may be granted, although it may be pointed out that even with regard to intelligence there is evidence from a number of long-term studies that I. Q. if not very unstable is at least not quite as constant as it has been commonly presumed.¹ But what about the measures of special abilities? Are these functions inborn and, therefore, relatively constant or are they the product of training and environmental influence, and therefore, relatively inconstant? To be more precise, what is the relative influence of heredity and environment in their determination? A brief examination of this question with respect to practical aptitude is in place.

Unfortunately there are no suitable long-term studies or studies employing matching techniques on this subject and until evidence from such studies is available nothing can be professed with any great certainty regarding the innate or environmental basis of this function, as also regarding its constancy or otherwise over a long period. Burt's view that practical ability is more dependent on interest, opportunity and experience than on inborn aptitude has already been mentioned. An examination of some of the evidence bearing on the three practical factors, m^2 , F and k would on the whole seem to support Burt's view. It must be stressed that the mere appearance of a certain factor in a given group says nothing about whether the factor is inborn or a product of the environment, or about the extent to which it is determined by both heredity and environment. If, however, a factor which appears in one group (say a group of 14 year old boys), fails to appear in another (say a group of 11 year old boys or 14 year old girls), the difference between the two groups being only with regard to their past experience, the suggestion that the factor in question may have been conditioned by training and experience becomes plausible. With this in mind, let us briefly consider some of the relevant data bearing on the different practical factors.

About m , there appears to be good agreement among investigators that the factor is to a considerable extent dependent on

1. For a competent interpretation of evidence of this kind see C.M. Fleming's *Adolescence, its Social Psychology*, Routledge & Kegan Paul, Ltd. London, 1948, particularly Chapter IX on Variety and Variability, pp. 87-117.
2. m is J. W. Cox's symbol for mechanical aptitude.

previous training. The verbal medium in which certain of Cox's tests are answered, the special knowledge of wheels, pulleys, levers, etc. required in answering all his tests, the fact that Cox failed to find evidence for m in his girl subjects, coupled with the evidence of Rao's investigation¹ strongly suggest that the factor in question does not denote any inborn aptitude as was believed by Cox, but is largely a product of training and experience. Regarding F , the position is more difficult to decide. Alexander's own groups consisted all of older subjects, except one whose findings were not reliable for reasons stated earlier (page 4). Drew's evidence reporting the presence of F in 11 year old subjects also cannot be treated seriously for reasons given on page 5. About k , again, nothing can be said conclusively, although there is some reason to believe that the factor is not entirely free from environmental determination. There is considerable evidence (Drew's, Slater's etc.) that in young subjects, say below the age of 12, spatial tests are measures of g only. This coupled with Clarke's failure to report evidence for this factor in his population which consisted of girls only, lends support to the view that k may also to some extent be a function of one's education and experience. Some of Clarke's remarks are particularly instructive in this connexion. Comparing his factorial results in which no evidence was found for k with the earlier findings of Koussy, he wrote: "Two possible explanations may be put forward for the difference between our own and Koussy's results. Koussy's population was boys, ours was girls, and there are many suggestions that the former are subjected to differentiations which might produce a factor such as k ... This, for the present, seems the most likely possibility."² Commenting on Alexander's and Cox's investigations, he further wrote: "Alexander and Cox have found group factors operative in other non-verbal material involving the appreciation of spatial relations, namely, in performance tests and tests of mechanical ability respectively. These, however, must be taken (until other evidence is available) to be expressions of differential training and experience, and not evidence for a universal space factor such as k might well have been..."³

The main conclusions that seem to emerge from the discussions undertaken in this study may now be summarised:

(1) The evidence on the measurability of practical ability at 11 plus is conflicting. under such uncertain conditions, the allocation of young children to technical education at 11 plus cannot be justified.

(2) The validity of the typological and related assumptions

1. Rao, K. G. R. "Comparative Value of Certain Verbal and Non-Verbal (Primary Perceptual) Tests and Their Relation to Tests of Mechanical Ability", 1933, Ph.D. thesis in the London University Library.
2. Clarke, G. 'The Range and Nature of the Factors in Perceptual Tests', 1937, Ph.D. thesis in the University of London Library, pp. 154-155.
3. Clarke, G. *Ibid.*, p. 157.

concerning the inborn nature and constancy of the practical function are open to question.

The Hadow Committee of the United Kingdom had after a careful examination of the question regarding the age of admission to junior technical schools in the light of the evidence then available, suggested "We think that it is highly inadvisable that a boy or girl should be placed at so early an age as that of 11 in a school planned to give a course of definitely vocational education. The arrangement by which pupils are admitted to junior technical schools at the age of 13 greatly diminishes the risk of committing the child to a course which may ultimately prove unsuitable, and *we accordingly recommend that for the present the normal age of entry to these schools should remain fixed at 13.*"¹ The present study would entirely support such a recommendation.

1. *The Education of the Adolescent*, His Majestys's Stationery Office London, 1920, p. 67.

